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Severe Burning Treatment Tested on Lowland Pine Sites

Station Paper No. 64

Northeastern Forest Experiment Station

Upper Darby, Pennsylvania
Ralph W. Marquis, Director

1953

United States Department of Agriculture • Forest Service

Severe Burning Treatment Tested on Lowland Pine Sites

by

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A NEW PROBLEM

Since the prescribed use of fire is a fairly new silvicultural technique for preparing seedbeds for pine in the New Jersey pine region, it has been used rather cautiously. Burning treatments have been made in the winter, when periodic light fires can be easily controlled. The treatments have been used almost exclusively on upland sites.

Then in 1951 a landowner asked for assistance in managing a 1,150-acre tract where he planned to harvest the pulpwood and sawtimber. Located in Burlington County (near Red Lion), this forest land was mostly on lowland sites.

Lowland sites like this make up about 14 percent of the forest area in the New Jersey pine region. The stands

[1]Stationed at the Lebanon Experimental Forest, New Lisbon, N.J., which is maintained by the Northeastern Forest Experiment Station in cooperation with the New Jersey Department of Conservation and Economic Development, Bureau of Forestry, Parks, and Historic Sites.

are composed of pitch pine, mixed with minor amounts of hardwoods. If left alone, they would develop into a climax type composed of worthless hardwoods.[2]

This particular tract of timber had a dense understory of shrubs and briers, and a thick layer of duff on the forest floor. The pulpwood cutting planned would take pines as small as 4 inches in diameter (diameter breast high); and the smaller trees on the tract were mostly suppressed, poorly-formed, slow-growing sprouts. Indications were found of a heavy mouse population, which could be expected to consume many of the pine seeds that fell.

This was a difficult tract to treat, even though increased use of prescribed burning has brought about improved techniques and skilled crews. However, detailed study of an accidental fire near North Branch in the summer of 1947--and its effect on the forest--indicated that a severe fire might be the best treatment for this tract.

So for this tract the state foresters prescribed a hot summer fire, to be followed by a seed-tree cutting.

THE SITES TO BE TREATED

Portions of the tract bounded by roads and swamps were to be treated. Four different types of sites occurred in these areas. These were wet, medium, and dry sites of the pine lowlands, and adjoining upland sites in some places.

Wet Sites

The wet sites were characterized by a pine overstory, an understory of swamp hardwoods and tall shrubs (6-12 feet tall), and a fairly deep forest floor (duff or organic mat). While the forest floor varied in thickness from 0.25 to 1.0 foot, in the sampled areas the estimated average depth before treatment was 0.5 to 0.9 foot. These wet sites had far more hardwood trees than the other sites sampled (table 1). Here red maple and blackgum, about equally common, made up 65 percent of the hardwoods; gray birch made up 21 percent. The other species were sweetbay, holly, willow oak, southern red oak, and sweetgum.

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[2] Little, S. The effects of forest fires on the stand history of New Jersey's Pine Region. Northeast. Forest Expt. Sta., Forest Mangt. Paper 2. 43 pp., illus. 1946.

Table 1.--Forest composition before treatment, by site

(Number of stems per acre)

Species group and d.b.h. (in inches)		Wet lowland	Medium lowland	Dry lowland	Upland
Pitch pines	1-3	37	480	461	59
	4-6	91	167	183	61
	7-10	57	37	37	20
	11-15	37	5	11	6
	All sizes	222	689	692	146
Hardwoods	1-3	230	52	9	2
	4-6	59	2	0	11
	7-10	15	0	0	7
	11-15	0	0	0	4
	All sizes	304	54	9	24

The understory was composed of many shrubs, but highbush blueberry (Vaccinium corymbosum) was the most characteristic. Other common tall shrubs were Clethra alnifolia, Gaylussacia frondosa, Rhododendron viscosum, Lyonia ligustrina, Leucothoe racemosa, and Amelanchier canadensis. Smaller shrubs included Kalmia angustifolia, Lyonia mariana, Chamaedaphne calyculata, Ilex glabra, and Vaccinium angustifolium. Briers (Smilax glauca and rotundifolia), ferns (chiefly Osmunda cinnamomea), and occasional spots of Sphagnum moss (sometimes with cranberry vines) were also present. However, not all these plants occurred in every plot.

Medium Sites

The medium sites were characterized by a pine overstory, a dense understory of shrubs about 3 feet tall, and a forest floor that averaged in unburned areas about 0.5 foot deep. This floor varied locally from 0.25 to 1.0 foot deep. Hardwood trees were far less common than on the wet sites (table 1). The hardwoods were chiefly red maple and blackgum with an occasional sweetbay.

The characteristic shrubs here were Kalmia angustifolia, Lyonia mariana, and Chamaedaphne calyculata; but Gaylussacia frondosa, G. dumosa, G. baccata, Aronia spp., and Ilex glabra were fairly common, along with scattered tall shrubs of the wetter sites (Vaccinium corymbosum, Rhododendron viscosum, Lyonia ligustrina, and Clethra alnifolia). But here these species were not so tall as on the wetter sites. One other common plant was Smilax glauca, while such plants as S. rotundifolia, Xerophyllum asphodeloides, and bracken fern were sometimes present.

Both the wet and medium sites were on Leon (formerly called St. Johns) soils.

Dry Sites

The dry sites were characterized by a pine overstory, a less dense stand of smaller shrubs than on the medium sites, and a forest floor about 0.25 foot deep. These sites usually had a heavy stand of bracken fern after the fires, sometimes had some lichens, sedges, and heather (Hudsonia ericoides); but had very few hardwood trees (usually an occasional blackgum, sweetbay, or oak). These sites were on Lakehurst soils.

The characteristic shrub was Leiophyllum buxifolium, but over this were usually about the same species of shrubs mentioned above--except that the scattered tall shrubs of the medium sites were usually absent.

Upland Sites

Upland sites had a much more open overstory of pine than the lowland sites (table 1), and the hardwoods were upland oaks--post oak, black oak, white oak, and chestnut oak. Far more common than these tree oaks were the stems of scrub or bear oak, which in the unburned areas reached heights of 6 to 10 feet.

Occasionally below the scrub oaks the ground was covered with lichens, but usually by smaller shrubs. These always included Gaylussacia baccata and either Vaccinium pallidum or V. angustifolium. Other common plants were Smilax glauca, Gaylussacia frondosa, and bracken fern.

The forest floor on these upland sites was relatively thin, usually averaging about 0.2 foot. Locally it varied from practically none in the spots covered with lichens to 0.3 foot. All the upland sites were on Lakewood soils.

THE BURNING TREATMENT

About 240 acres in this ownership were treated with prescribed fires in September and October 1951.

Part of the tract was burned in September. This was a severe summer type of fire. This hot fire was obtained after a long relatively dry period (only 2.37 inches of rain were recorded at the Lebanon Experimental Forest between July 20 and September 14).

The part of the tract treated in October had a relatively light burn. The fuels on the forest floor were wetter at that time (4.02 inches of rain were recorded in the period October 7 to 11).

In the burning, no attempt was made to save pines that were unmerchantable for pulpwood. The plan was to rely entirely on new reproduction starting after the fire and cutting operation. All the burning was done before any appreciable amount of the 1951 crop of pine seeds fell.

STUDY OF THE EFFECTS

In July 1952 a series of sample plots was set up and the results of the burning treatment were studied.

The plots were located so they were representative of the different types of burn (or unburned areas) and of the different types of site. They were restricted to areas having a fair source of seed. They also were restricted to areas where there had been no recent logging (since March) and slash that would have influenced unfavorably the establishment of pine seedlings.

The plots were set up by establishing three 2-chain strips for each treatment on each kind of site. Along each strip ten milacre quadrats, centered on the chain and selected at random, were used in studying reproduction.

The following were tallied on each quadrat: Number of pine seedlings of 1952 origin; number of older pine seedlings or sprout clumps (with the dominant stem less than 0.6 inch d.b.h.); and height of the tallest pine seedling, in tenths of feet. On each strip the understory, the forest floor, and the effect of the fire (if any) were briefly described.

A strip 3 milacres wide (19.8 feet) along the whole 2-chain strip was used in studying the overstory. The overstory in this strip was tallied by species, 1-inch diameter classes, and injury classes.

Thus the tallies included 360 milacre quadrats for study of reproduction, and 2.16 acres for study of overstory conditions.

Table 2.--Effect of light prescribed fire on pines

Site	Damage class	Size class (in inches)[1]				
		1-3	4-6	7-10	11-15	All sizes
		Percent	Percent	Percent	Percent	Percent
Wet lowland:	Uninjured	100	100	100	100	100
	Sprouting in crown	--	--	--	--	--
	Killed--basal sprouting	--	--	--	--	--
	Killed--no sprouting	--	--	--	--	--
Medium lowland:	Uninjured	41	84	100	--	58
	Sprouting in crown	--	3	--	--	1
	Killed--basal sprouting	8	--	--	--	5
	Killed--no sprouting	51	13	--	--	36
Dry lowland:	Uninjured	46	88	100	--	60
	Sprouting in crown	4	--	--	--	3
	Killed--basal sprouting	12	5	--	--	9
	Killed--no sprouting	38	7	--	--	28
Upland:	Uninjured	80	100	100	100	91
	Sprouting in crown	7	--	--	--	3
	Killed--basal sprouting	--	--	--	--	--
	Killed--no sprouting	13	--	--	--	6

[1]Trees 1-3 inches are mostly suppressed stems of sprout origin and undesirable as crop trees. Larger trees are merchantable for pulpwood.

Table 3.--Effect of severe prescribed fire on pines

Site	Damage class	Size class (in inches)[1]				
		1-3	4-6	7-10	11-15	All sizes
		Percent	Percent	Percent	Percent	Percent
Wet lowland:	Uninjured	17	71	50	100	55
	Sprouting in crown	--	5	--	--	2
	Killed--basal sprouting	--	--	--	--	--
	Killed--no sprouting	83	24	50	--	43
Medium lowland:	Uninjured	--	--	--	--	--
	Sprouting in crown	--	--	--	--	--
	Killed--basal sprouting	--	--	--	--	--
	Killed--no sprouting	100	100	100	--	100
Dry lowland:	Uninjured	3	36	86	100	18
	Sprouting in crown	3	28	--	--	10
	Killed--basal sprouting	1	--	--	--	1
	Killed--no sprouting	93	36	14	--	71
Upland:	Uninjured	--	18	50	--	17
	Sprouting in crown	--	--	--	--	--
	Killed--basal sprouting	25	--	--	--	5
	Killed--no sprouting	75	82	50	100	78

[1]Trees 1-3 inches are mostly suppressed stems of sprout origin and undesirable as crop trees. Larger trees are merchantable for pulpwood.

RESULTS

The severe fires were, of course, much more damaging to overstory trees than the light fires. On the medium and dry sites the severe fires killed (or killed back) all hardwoods and a large proportion of the pines. The light fires killed 63-100 percent of the hardwoods and about 40 percent of the pines (tables 2-5). Damage in the wettest sites was less because the burn there was spotty, so that even the severe fires killed only about 40 percent of the pines and 55 percent of the hardwoods.

But in modifying conditions for the establishment of pine seedlings in 1952, the important result was the effect of the fires on the forest floor (table 6).

Advance Reproduction

On unburned areas there was very little advance pine reproduction: less than 100 per acre on the average (table 7). On the medium and wet sites these were the rare seedlings that had started, usually on spots of sphagnum moss, while on the drier sites there were seedlings that had started on spots having a very thin forest floor. But in none of the areas studied did these seedlings stock more than 10 percent of the quadrats.

The prescribed-burning treatments reduced the amount of advance reproduction (table 7). On all sites, seedlings of poor vigor were probably killed and did not sprout. And on the wetter sites, where the severe fires burned deep, even vigorous seedlings did not sprout.

New Reproduction

The unburned areas provided very poor conditions for the establishment of additional pine seedlings from the 1951 seed crop. There 67 seedlings or less started per acre, stocking no more than 3 percent of the quadrats (table 7).

The light fires so improved seedbeds on the pine-lowland sites that the number and stocking of pine seedlings increased greatly. The severe fires were even more effective. And they also greatly favored the establishment of pine seedlings on upland sites (table 7).

Consequently, the study showed that type of fire was the most important (and highly significant statistically) factor affecting the amount and stocking of pine reproduction. Site was also highly important; the interaction of site and fire was also significant.

Table 4.--Effect of light prescribed fire on hardwoods

Site	Damage class	Size class (in inches)				
		1-3	4-6	7-10	11-15	All sizes
		Percent	Percent	Percent	Percent	Percent
Wet lowland:	Uninjured	76	100	100	--	81
	Sprouting in crown	--	--	--	--	--
	Killed--basal sprouting	24	--	--	--	19
	Killed--no sprouting	--	--	--	--	--
Medium lowland:	Uninjured	31	--	--	--	31
	Sprouting in crown	6	--	--	--	6
	Killed--basal sprouting	63	--	--	--	63
	Killed--no sprouting	--	--	--	--	--
Dry lowland:	Uninjured	--	--	--	--	--
	Sprouting in crown	--	--	--	--	--
	Killed--basal sprouting	100	--	--	--	100
	Killed--no sprouting	--	--	--	--	--
Upland:	Uninjured	--	--	100	--	100
	Sprouting in crown	--	--	--	--	--
	Killed--basal sprouting	--	--	--	--	--
	Killed--no sprouting	--	--	--	--	--

Table 5.--Effect of severe prescribed fire on hardwoods

Site	Damage class	Size class (in inches)				
		1-3	4-6	7-10	11-15	All sizes
		Percent	Percent	Percent	Percent	Percent
Wet lowland:	Uninjured	36	67	100	--	42
	Sprouting in crown	2	11	--	--	3
	Killed--basal sprouting	13	11	--	--	13
	Killed--no sprouting	49	11	--	--	42
Medium lowland:	Uninjured	--	--	--	--	--
	Sprouting in crown	--	--	--	--	--
	Killed--basal sprouting	67	--	--	--	67
	Killed--no sprouting	33	--	--	--	33
Dry lowland:	Uninjured	--	--	--	--	--
	Sprouting in crown	--	--	--	--	--
	Killed--basal sprouting	100	--	--	--	100
	Killed--no sprouting	--	--	--	--	--
Upland:	Uninjured	--	--	--	50	14
	Sprouting in crown	--	--	--	--	--
	Killed--basal sprouting	100	50	--	--	29
	Killed--no sprouting	--	50	100	50	57

Table 6.--Summary of changes wrought by prescribed burning

Site	Type of fire	Effect on forest floor	Effect on shrubs
Wet lowland	Severe	All consumed over much of area, although in spots some left. And in spots of two plots only litter consumed	Usually killed; stems of many consumed; not sprouting where fire burned deep.
	Light	Depth reduced about 0.1 foot.	Usually killed, but sprouted vigorously. In spots some not even killed.
Medium lowland	Severe	In one plot all consumed; in other plots all consumed in spots and reduced by a half in other spots.	Killed, stems usually consumed; not sprouting where fire burned deep (on 60% of area), but sprouting elsewhere.
	Light	Reduced 0.1-0.3 foot in depth.	Killed, stems sometimes consumed, but all sprouted vigorously.
Dry lowland	Severe	Nearly all consumed, leaving usually less than 0.1 foot.	Killed, most stems consumed, but sprouted vigorously.
	Light	Reduced about 0.1 foot, leaving on the average slightly more than 0.1 foot.	Killed, stems sometimes consumed, but all sprouted vigorously.
Upland	Severe	Nearly all consumed.	Killed, smaller stems sometimes consumed, but all sprouted vigorously.
	Light	Slightly reduced, usually by 0.1 foot or less.	Some scrub oaks not killed. Others and smaller shrubs killed, stems not consumed, sprouted vigorously.

Height Of 1952 Seedlings

Even though heights of these seedlings were measured only to the nearest tenth of a foot, the data indicated that seedlings tended to be taller on the wetter sites and on the most severely burned areas (table 7). However, no significant differences were obtained.

Probably significant differences would have resulted from a larger number of more detailed measurements. Haig reported taller seedlings of loblolly pine on burned than on unburned areas,[3] and a similar result was obtained in 1952 in a study on the Eastern Shore of Maryland. Also, the differences between sites in this study were even greater than the differences between burns.

[3] Southeast. Forest Expt. Sta. Biennial Report, 1947 and 1948. 61 pp., illus. 1949.

Table 7.--Pine reproduction in relation to type of fire and site

Type of fire	Wet lowland	Medium lowland	Dry lowland	Upland
	ADVANCE SEEDLINGS OR SPROUT CLUMPS PER ACRE			
	Number	Number	Number	Number
None	133	100	67	33
Light	0	0	0	0
Severe	0	0	100	0
	1952 SEEDLINGS PER ACRE			
	Number	Number	Number	Number
None	67	0	67	0
Light	200	1,300	2,533	0
Severe	6,700	6,900	22,800	900
	QUADRATS STOCKED WITH 1952 SEEDLINGS			
	Percent	Percent	Percent	Percent
None	3	0	3	0
Light	17	40	73	0
Severe	80	100	100	47
	AVERAGE HEIGHT OF 1952 SEEDLINGS[1]			
	Feet	Feet	Feet	Feet
None	0.20	--	0.10	--
Light	0.10	0.14	0.12	--
Severe	0.21	0.16	0.13	0.13

[1]Tallest seedlings on stocked quadrats.

CONCLUSIONS

One deep-burning fire in a seed year seems to be a highly effective way of reproducing pine on the medium and wet sites of pine lowlands in southern New Jersey. Here such a fire prepares a highly favorable seedbed and eliminates much of the competition from hardwoods and shrubs. The deeper the burn, the better it is for doing this.

However, because of the spottiness of the burn in the wettest places, and the number of hardwoods usually found there, further hardwood control will usually be needed to obtain pure pine stands there. Such control might be obtained by poisoning surviving trees with ammate. For ease of working, this control work should be done within a year or two after the fire--before new growth makes the area less open.

Disadvantages of using a deep-burning fire lie chiefly in timing. Probably only certain years provide ideal conditions. Consequently, the burning would have to be done

then, either in areas that had already had a seed-tree cutting or in areas that were to be so cut within a year. Because of damage to the overstory (table 3) such a cutting should be made within a year after burning.

A deep-burning fire is far more expensive than a light fire; it requires 1 to 5 man-hours per acre.

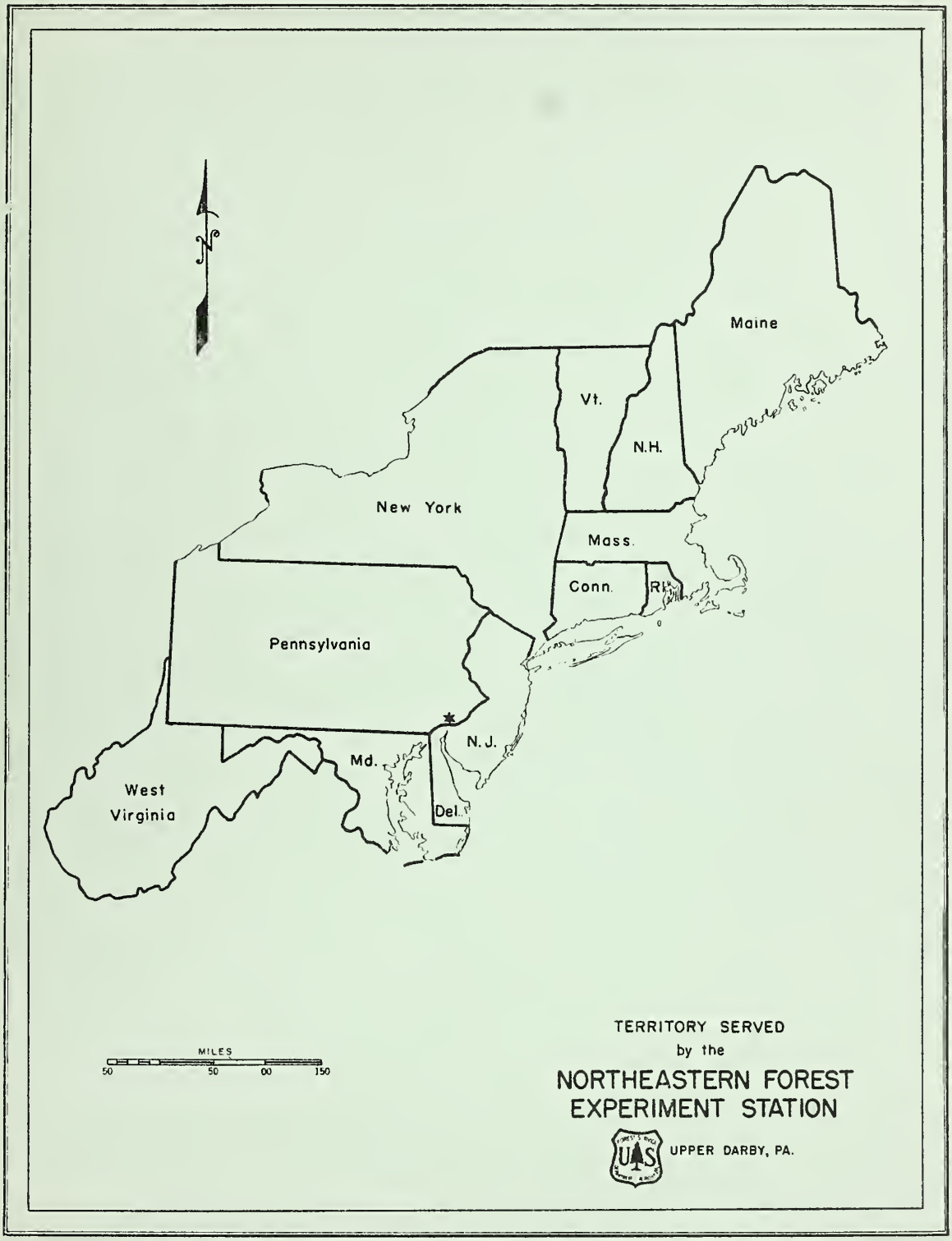
On the dry portions of the lowlands and on upland sites, the forest floor does not build up to sufficient depths so that deep-burning fires are possible. Consequently, there both hardwood trees and shrubs usually sprout vigorously after a hot fire--although large hardwood trees may not.

On these sites several light winter fires produce fully as favorable results as one hot summer fire. The former cause a more permanent reduction in shrubs and provide conditions suitable for advance pine reproduction. Obtaining such reproduction is, of course, most desirable on upland sites where the amount of reproduction obtained from one seed crop is relatively small (table 7).

Consequently, while one hot summer fire is much better than none on the drier portions of the pine lowlands and on the uplands, the authors believe that its use is most applicable in the wetter sites of the lowlands where it may burn deep.

There the use of summer fires offers strong promise for solving the problem of establishing the desired type of stand. Admittedly there are great difficulties in obtaining the proper type of fire. But the authors believe that no other method offers so practical a solution, and that the difficulties can be overcome with sufficient planning, organization, and experience.

Agriculture - Forest Service - Upper Darby, Pa.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